NUCLEOBASES AND OTHER PREBIOTIC SPECIES FROM THE UV IRRADIATION OF PYRIMIDINE IN ASTROPHYSICAL ICES.

S. A. Sandford[1], M. Nuevo[1,2], C. K. Materese[1,2],. [1]NASA Ames Research Center, Moffett Field, CA 94035, USA, [2]SETI Institute, Mountain View, CA 94043, USA

Introduction: Nucleobases are aromatic **N**-heterocycles that constitute the informational subunits of DNA and RNA, and are divided into two families: pyrimidine bases (uracil, cytosine, and thymine) and purine bases (adenine and guanine). Nucleobases have been detected in meteorites [1,2] and their extraterrestrial origin confirmed by isotope measurement [3]. Although no **N**-heterocycles have been individually identified in the ISM [4,5], the 6.2-μm interstellar emission feature seen towards many astronomical objects suggests a population of such molecules is likely present [6]. We report on a study of the formation of pyrimidine-based molecules, including nucleobases and other species of prebiotic interest, from the ultraviolet (UV) irradiation of pyrimidine in low temperature ices containing H_2O, NH_3, CH_3OH, and CH_4, to simulate the astrophysical conditions under which prebiotic species may be formed in the interstellar medium, protosolar disk, and icy bodies in the Solar System.

Experimental: Gas mixtures were prepared in a glass mixing line (background pressure ~10^{-6}–10^{-5} mbar; relative proportions between components were determined by their partial pressures). Gas mixtures were then deposited on an Al foil attached to a 15-20 K cold finger and simultaneously irradiated with an H_2 lamp emitting UV photons (Lyman _ and a continuum centered around 160 nm). After irradiation samples are warmed to room temperature, at which time any remaining residues are recovered to be analyzed with liquid and gas chromatographies.

Results: These experiments showed that the UV irradiation of pyrimidine mixed in these ices at low temperature leads to the formation of several photo-products derived from pyrimidine, including the nucleobases uracil [7,8] and cytosine [8], as well as their precursors 4(3**H**)-pyrimidone and 4-aminopyrimidine [7,8]. Theoretical quantum calculations on the formation of 4(3**H**)-pyrimidone and uracil from the irradiation of pyrimidine in pure H_2O ices are in agreement with their experimental formation pathways [9]. In those residues, other species of prebiotic interest such as urea and the amino acids glycine and alanine are also be identified [8]. Pyrimidine derivatives containing CH_3 groups, including the nucleobase thymine, are also seen, but are made with much lower efficiencies [10], perhaps explaining why this nucleobase has yet to be identified in meteorites.

References: [1] van der Velden W. and Schwartz A., (1977) □**eoc**□**im. Cosmoc**□**im. Acta**, 41, 961. [2] Stoks P. and Schwartz A. (1979) **Nature**, 282, 709. [3] Martins Z. et al. (2008) **Eart**□ **Planet. Sci. Lett.**, 270, 130. [4] Kuan Y.-J. et al. (2003) **Mont**□. **Not. R. Astron. Soc.**, 345, 650. [5] Charnley S. B. et al. (2005) **Ad**□. **Space Res.**, 36, 137. [6] Hudgins D. M. et al. (2005) **Astrop**□□**s.** □, 632, 316. [7] Nuevo M. et al. (2009) **Astro**□**iolo**□□, 9, 683. [8] Nuevo M. et al. (2012) **Astro**□**iolo**□□, 12, 295. [9] Bera P. P. et al. (2010) □. **C**□**em. P**□□**s.**, 133, 104303. [10] Materese C. K. et al. (2012) **Astro**□**iolo**□□, in preparation.